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Vol. I April, 1916 No. 4

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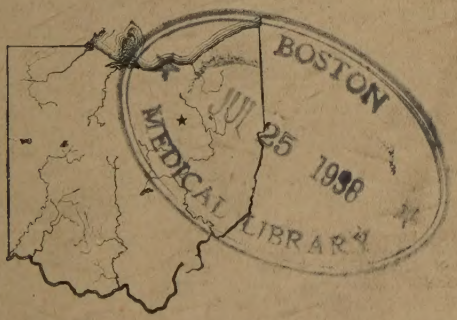
MONTHLY BULLETIN

OF THE

OHIO Agricultural Experiment Station

A report on the progress of the investigations of the Ohio Agricultural Experiment Station, sent free to all residents of the State who request it.



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Monthly Bulletin

of the

Ohio Agricultural Experiment Station

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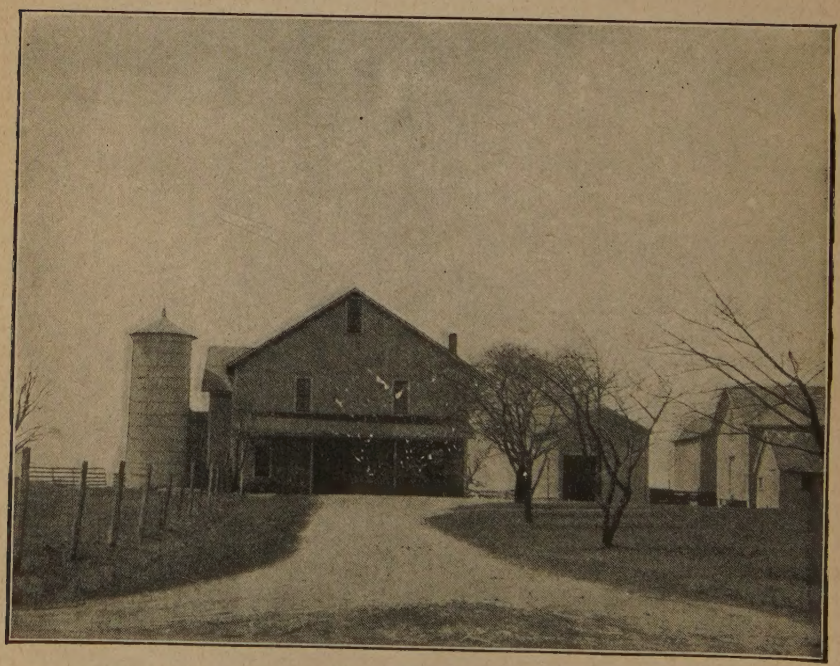

Photo by C. W. Montgomery

Residence and barn on the Trumbull County Experiment Farm

MONTHLY BULLETIN

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Ohio Agricultural Experiment Station

VOL. I APRIL, 1916 NO. 4

VARIETIES OF SOYBEANS

F. A. WELTON

The weather conditions during the last winter have been such as will likely result in the partial or complete failure of many fields of wheat and undoubtedly a large number of meadows both old and new seedings. In extreme cases the failures will be manifest in ample time to plow the fields for spring seeding with such crops as oats or corn, but in many the winter killing may not be apparent till it is too late to seed such crops. In the latter event soybeans may be substituted to good advantage because they are not seeded normally until all danger of frost is past—usually the latter part of May or the first of June. In some sections of southern Ohio cowpeas are acceptable, but for general use throughout the State they are inferior to soybeans, the latter having yielded, on the Station farm, about three times as much seed per acre as the former. General information regarding the growing of soybeans is given in Bulletin 237. More recent data concerning varieties only are reported herein.

The wise choice of varieties depends on what use is to be made of the crop. If grown for seed not only yield and retention of beans are important, but it is essential that a variety be chosen which will mature in the average season. If grown for hay then quantity and quality of forage are of first importance. If cut for the silo such characters as retention of beans and fineness of stems are of no particular moment, as the beans should be cut before the seed ripens and the stems, regardless of size, will be softened by the juices in the silo. Large, leafy varieties are preferable for this purpose.

Notes regarding 25 varieties as tested for the production of seed at the main Station at Wooster are given in Table I. The numbers before which the word "Ohio" is placed refer to promising strains developed by the Station, each from a single plant.

TABLE I.—Twenty-five varieties of soybeans

Variety	Seed		Time of maturity	Retention of beans	4-year average yield per acre	
	Size	Color			Grain	Straw
					Bushels	Pounds
Chestnut	Medium	Yellow	Early	Good	28.39	2,035
Ito San	"	"	"	Excellent	21.96	2,060
Ito San 17268	"	"	"	"	27.56	2,300
Ohio 9100	"	"	"	"	21.92	2,057
Manchuria	"	"	"	Good	25.88	2,057
Ohio 9001	"	"	"	Fair	25.95	1,932
Average of early					25.28	2,073
Amherst	"	"	Medium	Good	24.51	2,420
Auburn	"	Black	"	"	23.50	2,255
Ebony	Small	"	"	"	25.19	2,255
Habaro	Medium	Yellow	"	"	24.87	2,290
Hollybrook	"	"	"	"	23.59	2,420
Medium Green	"	Green	"	Fair	22.71	2,670
Mongol	"	Yellow	"	Good	25.95	2,362
Ohio 7496	Large	"	"	Fair	29.86	2,487
Ohio 9016	"	"	"	Good	31.19	2,265
Ohio 9110	Medium	Green	"	Fair	28.51	2,485
Shingto	"	Olive	"	Good	25.92	2,607
Wing's No. 1	Small	Black	"	Fair	22.18	1,682
Yosho	Medium	Olive	"	Good	21.41	2,435
Average of medium					25.34	2,356
Cloud	Small	Black	Late	Good	19.79	2,690
Mikado	Medium	Yellow	"	"	21.69	2,117
Ohio 7491	Large	"	"	"	26.28	2,660
Ohio 9035	Medium	Brown	"	Excellent	25.58	2,712
Sable	Small	Black	"	Good	15.13	2,407
Taha	Medium	Black and Yellow	"	"	21.64	2,915
Average of late					21.68	2,583

The varieties ripening on or before September 27 are classed as early; those from September 28 to October 6, inclusive, as medium; and those on or after October 7, as late.

From the foregoing table it is apparent that in northern Ohio the early and medium varieties are preferable to the late ones, though the yield of two of the latter is equal to that of the average of each of the other two classes. Among the early varieties, two—the Chestnut and Ito San 17268—have a 4-year average yield exceeding 27 bushels per acre. While the average yield of all the medium maturing soybeans is practically the same as that of the early, yet three varieties—Ohio 7496, Ohio 9016 and Ohio 9110—rank highest in the entire list of 25, all having an average above 28 bushels per acre. Of the late varieties, Ohio 7491 and Ohio 9035 rank highest. The latter is especially resistant to shattering.

For the production of hay of good quality the Station's tests indicate the use of such varieties as the Cloud, Ohio 9035, Sable, Taha, Auburn, Ebony, Medium Green and Shingto.

For silage, varieties of the type of the Medium Green give excellent results. With respect to maturity this variety is well adapted for use in northern Ohio, but in central and southern Ohio, where the season is somewhat longer than at Wooster, probably some of the later varieties, like the Ohio 9035 or Taha, would be more satisfactory.

Cooperative work.—After 9 years' work the Station has isolated a few strains which seem to possess superior merit with respect to such characters as yield and retention of beans. Limited quantities of these are now offered for distribution upon the following conditions:

Plan 1—3 pecks of one variety
Plan 2—1 peck each of 1 to 4 varieties
Plan 3—1 pint each of 1 to 4 varieties

In pint lots there will be no charge, but in lots of a peck or more the seed will be sold at the rate of 70 cents per peck including sack. The cooperator will be required to report results of tests to the Station. Upon request application blanks for seed will be sent, and it will be furnished as long as the supply lasts and in order of the receipt of the applications.

A WASTE LIME PRODUCT

C. E. THORNE

Common salt is a chemical combination of sodium and chlorine, known as sodium chloride. The compounds of soda known as sal soda, washing soda and baking powder, are combinations of sodium with carbon dioxide, forming carbonate or bicarbonate of soda. To convert common salt into baking soda, therefore, it is merely necessary to substitute carbon dioxide for the chlorine of the salt.

If sulphuric acid be mixed with common salt and heated, the chlorine of the salt will combine with the hydrogen of the sulphuric acid and pass off as hydrochloric-acid gas, leaving sulphate of soda —known as Glauber's salt. This sodium sulphate may be mixed with coal and limestone, which is carbonate of lime, and heated to fusion, when a double reaction takes place, resulting in the formation of sulphide of lime and carbonate of soda. These may be separated by leaching with water, the sodium carbonate being more easily dissolved than the lime salt.

Another method, now more generally employed, is to pass ammonia gas through salt brine and to follow with carbon-dioxide gas. Ammonium chloride will be formed and will remain in solution, while sodium carbonate will be precipitated as a powder. The

ammonium chloride is treated with slaked lime, which unites with the chlorine, driving off the ammonia as a gas, which is saved and used again, while the calcium chloride is thrown away as waste. No practicable method has yet been discovered to recover the chlorine in this product. To procure lime for this purpose limestone is burnt in kilns so constructed that the escaping gas may be saved, and this gas, which is carbon dioxide, is used for carbonating the salt. In this roundabout way common salt, which is sodium chloride, and crude limestone, which is calcium carbonate, are made to swap horses, the ammonia acting as the agent in the trade; and we have sodium carbonate on the one hand and a mixture of calcium chloride, calcium hydroxide and calcium carbonate with a few impurities on the other.

A large manufactory of sodium carbonate is located over a bed of salt, lying at a depth of half a mile in the ground. Wells have been driven into this salt bed; water is forced down and is pumped up as a saturated brine. Limestone is burnt by the hundreds of carloads to procure both the carbon dioxide needed for the conversion of the salt into carbonate and quicklime for the restoration of the ammonia. After the lime has been used for this purpose it becomes a waste product. An area of many acres has been covered with the waste lime to the depth of 10 feet or more.

This waste is now being dried and offered to farmers for the treatment of the land. It has become hydrated—that is, combined with water—in its use in the salt works. It has carried out with it some chlorine in the form of calcium chloride and common salt, but probably not enough to cause any injury, further than to reduce its value by whatever percentage of such constituents it may contain. It has absorbed some carbon dioxide in the factory and still more on exposure to the weather in the open field, and is now largely a mixture of hydrated lime and carbonate of lime. Its value for land treatment is probably equal to that of a good quality of raw ground limestone.

Farmers should remember that raw limestone is carbonate of lime; that, in burning, the carbon dioxide, which constitutes about 44 percent of the weight of the limestone, is driven off as a gas; that, therefore, 1 ton of burnt lime is of practically equal value as a land dressing to 2 tons of raw limestone; that when burnt lime is hydrated or exposed to the air, it absorbs about one-third its weight of water, and that hydrated lime therefore stands nearly midway between burnt lime and raw limestone in value as a land dressing.

SPRAYING PROGRAMS FOR THE SMALL HOME ORCHARD AND FRUIT GARDEN

H. A. GOSSARD AND W. J. GREEN

The farmer and fruit gardener is sometimes deterred from spraying because of the formidable look of the long spraying programs which are recommended for the use of commercial fruit growers who give all their time to fruit production and, therefore, are anxious to obtain the best crop insurance possible, regardless of the outlay of either time or money. On the average, fair results can be obtained with shorter programs, and, hence, the following abridged programs are recommended to the attention of busy owners of small orchards who have not the time to insure their crops completely.

To learn how to prepare sprays at home, send for the spray calendar, Bulletin 232 of this Station. Complete programs are given in Circular 149.

APPLE SPRAYING PROGRAM

No. 1 (Dormant spray).—The dormant spray should be given to all orchard trees, except possibly sour cherries, which are scarcely attacked by San Jose scale. Use either lime-sulphur solution—that is, the commercial concentrate, testing 33° Beaume or thereabouts, diluted with 7 parts of water—or a good miscible oil, usually diluted with 15 parts of water. For good results, spray from two or more sides of the trees with the wind when the temperature is 50° F. or warmer and the bark is dry. Good days in February and March should be utilized, but when delay is unavoidable it is better to spray even when the bloom is showing pink than to omit it on trees that are infested with scale. If the work is not done thoroughly, it is about as well not to do it at all, for the entire cost of the work will go for naught. For a tree 15 feet high and with an equal spread of top, use about 2 to 5 gallons of diluted lime-sulphur spray; for a tree 20 feet tall and with an equal spread of top, 5 to 10 gallons; for a tree 25 to 30 feet high and with an equal spread of top, from 10 to 15 gallons. If a miscible oil is used, about two-thirds of these quantities will suffice. Every bit of bark and bud surface must be wet with the spray. Inspect the work in a week or 10 days; and, if any spots escaped being covered, repeat the application over such areas.

No. 2 (Preblossom spray).—The preblossom spray should be given in neighborhoods where scab and cedar rust are at all prevalent, as in parts of southern Ohio. It is quite generally omitted in

northern Ohio, where orchardists use the dormant lime-sulphur spray as late as possible just as the leaves are pushing out of the buds. Some in southern Ohio omit it, but this is somewhat risky. The materials are Bordeaux, 6-6-50 formula, along with 40 percent nicotine sulphate 1 part in 700 of liquid (1 pint to 87½ gallons). Also, if cankerworms are abundant, add arsenate of lead paste, 4 pounds to 50 gallons of spray. Only one-half as much arsenate of lead powder, by weight, will be needed as of the paste form.

No. 3 (Calyx-cup spray).—This spray can never be omitted by the man who sprays at all. Freedom from worms in the apples depends upon it.

Lime-sulphur solution, commercial concentrate 1 part to 40 parts of water along with arsenate of lead paste 3 pounds to 50 gallons of spray is recommended. If apple lice or aphids are present, it is well to add nicotine sulphate 1 part to 700 of spray. Apply just after the blossoms fall.

This application should be very liberal; both surfaces of the leaves should be well bathed with spray, and it should be driven into the cup of every blossom. The tree will be dripping profusely before it is finished. Trees 15 feet high and with an equal spread of top will require from 3 to 5 gallons of spray; trees 20 feet tall and with an equal spread of top, from 8 to 12 gallons of spray; trees 25 to 30 feet tall and with an equal spread of top, from 15 to 20 gallons of spray. A driving mist directed into the flower-cups from a tower by means of a bamboo pole and angled nozzle will nearly always yield satisfactory results. The spraying should begin when about 90 percent of the petals have fallen and before the weight of the young fruit has turned the cups toward the ground. Ten days after bloom is close to the outer limit of the period within which this spraying can be satisfactorily done.

No. 4 (July or August spray).—Lime-sulphur, commercial concentrated solution 1 to 40—or in neighborhoods where blotch or bitter rot occurs, as in southern Ohio, Bordeaux, 2-2-50 formula—plus arsenate of lead paste 3 pounds to 50 gallons may be used. Add nicotine sulphate if aphids or young leaf-hoppers are abundant. In southern Ohio make this application about the first week in July; in the north, from the middle of July to the 10th of August.

The nicotine ingredient in these sprays is to reduce the sucking insects; and, since these are responsible for much fire-blight infection, the addition of nicotine to the sprays will tend to reduce the amount of fire blight.

PEAR SPRAYING PROGRAM

The spraying program for pears is the same as for apples except that ammoniacal copper carbonate (See Ohio Agr. Exp. Sta. Bul. 232.) should take the place of No. 4 about the second week in July. Do not try to combine the arsenicals with the ammoniacal copper carbonate spray.

PEACH SPRAYING PROGRAM

No. 1 (Dormant spray).—Use lime-sulphur, commercial concentrated solution diluted with 7 parts of water, or use the home-boiled preparation (See Ohio Agr. Exp. Sta. Bul. 169.). Apply in the spring just as the buds are swelling.

No. 2.—Use arsenate of lead paste 3 pounds to 50 gallons, about 10 days after the petals fall or when the blossom husks are shedding from the young fruit. This spray is necessary to reduce the curculio and to prevent wormy peaches.

No. 3.—Self-boiled lime-sulphur (See Ohio Agr. Exp. Sta. Bul. 232.) with arsenate of lead paste 3 pounds to 50 gallons should be applied in 10 days after No. 2.

No. 4.—To prevent brown rot, spray 3 or 4 weeks after No. 3 with self-boiled lime-sulphur, 8-8-50 formula, and repeat if necessary 2 or 3 weeks later. Many growers of peaches use the commercial concentrated lime-sulphur solutions diluted with 75 to 100 parts of water instead of the self-boiled mixture for sprayings Nos. 3 and 4, but they are not so effective in preventing the rot and are more likely to injure the leaves.

PLUM SPRAYING PROGRAM

FOR ALL VARIETIES

No. 1 (Dormant spray).—The commercial concentrated lime-sulphur diluted with 7 parts of water, or the home-boiled preparation should be applied in early spring for scale insects.

No. 2.—Use Bordeaux, 4-4-50 formula (See Ohio Agr. Exp. Sta. Bul. 232.) along with arsenate of lead paste 3 pounds to 50 gallons when the buds are swelling.

FOR EUROPEAN VARIETIES

No. 3.—Use Bordeaux, 4-4-50 formula, plus arsenate of lead paste 3 pounds to 50 gallons just after the calyx drops. This is to prevent fungous diseases and wormy plums, made so by the curculio.

No. 4.—Repeat No. 3 two weeks later. If brown rot is not prevalent, this spray may be omitted. If subsequent treatments seem necessary, see Circular 149 of the Ohio Experiment Station.

FOR AMERICAN AND JAPANESE VARIETIES

No. 3.—For American and Japanese varieties use the same spray as for the European varieties except that self-boiled lime-sulphur must be substituted for Bordeaux. The foliage of these varieties is easily injured.

No. 4.—This spray is the same as No. 3 and should be applied 2 weeks after it. If brown rot is not prevalent, this spray may be omitted. See Circular 149 of the Ohio Experiment Station for further treatments if such are needed.

CHERRY SPRAYING PROGRAM

No. 1.—Dormant spraying with lime-sulphur, scale strength, is occasionally advisable on sweet varieties for the Forbes scale. San Jose is rarely serious on sweet cherries and makes scarcely any headway on the sour varieties.

No. 2 (Preblossom spray).—Use Bordeaux mixture, 2-2-50 formula, with arsenate of lead paste 3 pounds to 50 gallons when the leaves are unfolding. This spray is effective against leaf-spot, mildew and the curculio.

No. 3.—Just after the blossoms fall, use arsenate of lead paste 3 pounds to 50 gallons, plus nicotine sulphate 1 part to 500 of spray, plus 2 pounds of soap dissolved in water to each 50 gallons. This spray will prevent wormy cherries, caused by the curculio, and will kill aphids or plant lice before they are greatly multiplied.

No. 4.—Self-boiled lime-sulphur (See Ohio Agr. Exp. Sta. Bul. 232.), plus arsenate of lead paste 3 pounds to 50 gallons, plus nicotine sulphate 1 part to 500 of spray should be applied about 1 week after No. 3.

No. 5.—After the fruit is picked, spray for leaf spot with Bordeaux, 2-2-50 formula, along with arsenate of lead paste 3 pounds to 50 gallons if slugs are present. If neither leaf-spot nor slugs are present, this spray may be omitted.

GRAPE SPRAYING PROGRAM

No. 1.—Bordeaux, 4-4-50 formula, should be used for mildew and black rot just before the blossoms open.

No. 2.—Repeat No. 1 just after the fruit sets.

No. 3.—Repeat No. 1 two weeks after No. 2. Add 4 pounds of arsenate of lead paste if beetles of the rootworm are present.

No. 4.—Bordeaux, 2-3-50 formula, plus arsenate of lead paste 6 pounds and 2 pounds of dissolved soap to 50 gallons should be applied thoroughly by hand under high pressure to the clusters of

fruit and to the vine from the 1st to the 10th of August. This spray is used to prevent berry-worm and fungous diseases.

CURRANT AND GOOSEBERRY SPRAYING PROGRAM

No. 1.—The dormant spray for scale insects, especially San Jose, is the same for currants and gooseberries as for other fruits.

No. 2.—When the leaves are unfolding use Bordeaux, 4-4-50 formula, for leaf spot and mildew.

No. 3.—After the leaves expand and just as the blooms begin to open, for leaf-spot, mildew and currant worms, use Bordeaux, 4-4-50 formula, plus arsenate of lead paste 3 pounds to 50 gallons. Add nicotine sulphate 1 part to 700 of spray if aphids are appearing. The arsenate of lead will adhere long enough to kill the currant worms when they first appear.

No. 4.—Whenever the currant worm is present, dust when the dew is on with hellebore 1 part and dry-slaked lime 4 parts or with Paris green diluted with 4 parts of lime. Hellebore is to be preferred if the fruit is three-fourths or more grown.

RASPBERRY AND BLACKBERRY SPRAYING PROGRAM

No. 1.—Use the dormant spray before the leaves appear. If the bushes are infested with rose scale, San Jose or other scales, spray with lime-sulphur solution in dormant strength.

No. 2.—If the pale brown beetle, *Byturus unicolor*, is present, use arsenate of lead 3 pounds to 50 gallons. and apply when the buds are swelling.

No. 3.—If Byturus is attacking the bloom, spray with arsenate of lead 3 pounds to 50 gallons while the blossoms are open.

No. 4.—For anthracnose, when young canes are 6 inches high, spray with Bordeaux, 4-4-50. keeping the spray away from the leaves on bearing canes.

STRAWBERRY SPRAYING PROGRAM

No. 1.—When the leaves are about one-half grown, before blooming, spray with Bordeaux, 6-6-50, for leaf-spot.

No. 2.—Young beds should be treated as above 1 week later. This spray is not needed on old beds.

No. 3.—For leaf-rollers and slugs, spray in late May or early June with a solution of hellebore 1 ounce in 3 gallons of water.

No. 4.—After the fruit is picked, mow the vines close to the ground and burn them on a windy day or remove and burn; or spray the new growth with Bordeaux, 6-6-50, for leaf-spot. Drouth following such a burning sometimes prevents a crop the next year.

PLANT LICE OR APHIDS

H. A. GOSSARD

Everybody who has had experience in growing plants either outdoors or indoors has made the acquaintance of the small plant lice, which in books are called aphids. These may be green, black, red or reddish, orange, white, gray or other colors. Some are marked with combinations of these colors. One of the species commonly found on the apple is suffused with reddish and is known as the rosy apple aphis; some other apple aphids are green, while one found on both the apple and the elm, is, in some of its stages, covered with a woolly growth, whitish, bluish or greenish. This insect is known as the woolly aphis of the apple and elm. Some others, more especially species of subterranean habits, are dusted with a coat of whitish, powder-like wax. Some examples of the underground forms are the lettuce-root louse and the cornroot aphis. Some of the species have both underground and aerial forms, differing greatly in appearance and habits. Some of these latter species live for part of the year on the roots and during the rest of the year on the part of the plant above ground. Examples are the grape phylloxera and the woolly apple aphis. The root forms and the aerial forms of the same species and also identical species inhabiting different hosts, may be so unlike that even skilled students of the aphid family may fail for years to recognize the two forms as belonging to the same species.

LIFE HISTORY AND HABITS

The stem-mothers.—As a rule, the general course of development for the different species is quite similar; hence the life history of any one species will parallel, in many points, the development of all others. Shining, glossy, jet-black eggs, so small as to escape all but the sharpest eyesight, are laid in the fall of the year upon suitable host plants; and these eggs hatch with the coming of warm spring weather. The louse coming from the egg is known as the "stem-mother." In an incredibly short time the stem-mother commences to produce living young by a budding process; and the new generation, succeeded by others, indefinitely repeat this budding process of reproduction. Yet, in all generations, numerous individuals, especially in overpopulated colonies, acquire wings and fly to new leaves, trees or plants, and found new colonies by this same budding method.

Rapid multiplication.—So prodigious are their possibilities for multiplication by this means that a celebrated naturalist, Thomas H. Huxley, once computed by observation and some underassumptions that the uninterrupted issue of a single stem-mother, if continued for 10 generations, would produce in the tenth generation a mass of animal matter equal in weight to that of 500,000,000 human beings, or five times the weight of our present population. This estimate is not questioned by any informed naturalist, but is judged to be under rather than above the actual possibility. The common apple louse passes through eight generations in one summer; thus it is easy to see what would happen to humanity if the multiplication of these lice was not cut short in some way. To prevent such a catastrophe as the destruction of present world arrangements nature depends upon many natural enemies to plant lice, as discussed in detail later.

Summer and fall hosts.—All the lice, belonging to several of the species, acquire wings about midsummer and fly to a new host plant, leaving the old host entirely clean of their presence. Thus the European grain louse lives on the apple in the spring, doing much damage; but in late May or thereabouts it leaves the orchard and settles upon fields of wheat and similar grain where it remains until fall, when it again returns to the orchard. Both sexes—true males and females—are developed; eggs are laid which hatch the next spring into stem-mothers, and the yearly cycle of changes is thus completed.

Honey-dew.—Nearly all the species secrete honey-dew and expel it through a pair of tubes on the back of the abdomen. This sweet fluid is very attractive to ants, and some kinds of ants care for the aphids and aphid eggs much as the human herdsman cares for his cattle. Thus, the common cornfield ant collects the eggs of the cornroot louse in the fall, stores them in its underground chambers, carries them up into the sunshine on warm winter days and back to the chambers before night, plants them on the roots of smartweed, foxtail and other weeds in early spring, and after the corn is well started transfers the young aphids to the cornroots, where they pass through several generations and are frequently visited by the ants in quest of honey dew.

Weather influences.—Aphids are generally noticed to be most plentiful in cold, cloudy, wet periods. If such weather is prolonged early in the season, plant lice are likely to become a plague in orchards and grainfields in May and June; while, if the opening season is continuously bright and dry, the aphids usually disappear quickly even though eggs were laid in abundance the preceding fall.

The natural enemies of the lice are sluggish in both movement and reproduction in cool weather. This is especially true of the minute hymenopterous parasites, which are so important in aphid control. If we examine a colony of aphids after a clear, warm spell, some among them will be seen inflated like miniature balloons, their bodies being only light-colored, brittle shells with circular holes in the backs through which the parasites have emerged. These parasites multiply rapidly in warm, fair weather; therefore, louse plagues are nearly always past by midsummer.

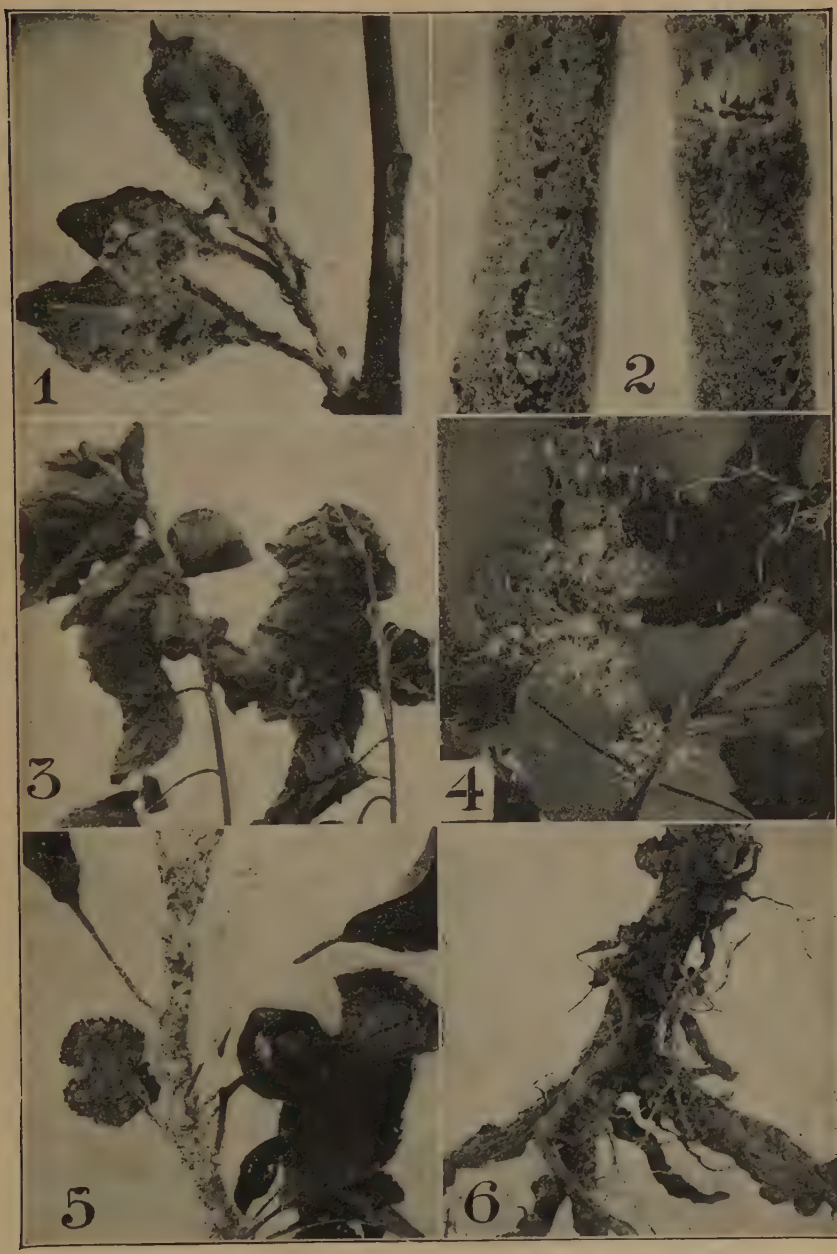
NATURAL ENEMIES

Insects.—Soft-bodied, slug-like creatures are often seen among the lice, the extensile, anterior end of the body being frequently held aloft as it seeks food or sucks the juices from a louse it has captured. These slug-like larvae are the young of syrphus flies, often called "sweat bees." These flies resemble bees in their brilliant coloring, but differ from them in having but two wings. Lady beetles and their larvae also destroy many aphids. Some of the lady-beetle larvae are curiously spined. The larvae of the lacewing or "golden-eyed" flies are also very common and effective enemies; their long scissorlike jaws and slender, elongated bodies render them easily recognizable; they are known as "aphis lions."

Birds and toads.—Among birds, about 50 different kinds of warblers pass through Ohio in early May, and these are great foragers on aphids. The vireos, fly-catchers and also other birds render good service in destroying aphids or their overwintering eggs. Toads devour many in gardens and greenhouses.

NATURE OF DAMAGE

Aphids suck the juices from leaves, fruit, stems and roots, causing wilting, malformations and discoloration. They often inoculate plants with the spores of infectious disease, or such spores may later gain entrance through their punctures. Cucurbit wilt and fireblight of the apple are thus carried from leaf to leaf and from plant to plant. A reddish or brownish blight of oats is also transferred in this manner. The spores of some diseases, such as fire blight, can live for several days in the honey-dew, which they excrete, and very probably are thus scattered far and wide by the syrphus or pollen flies, ants, wild bees and honey bees which habitually visit honey-dew. The roots of apple and pear become deformed and knotty under the attacks of the apple-root aphis; so do grape-roots when supporting the phylloxera. The leaves of plants attacked become much distorted and curled; and, in case of some of



1.—Apple aphids on the leaves; 2.—Winter eggs of apple aphids; 3.—Curling of wild-cherry leaves caused by aphids; 4.—Woolly maple-leaf aphids; 5.—Woolly apple aphids on the stem; 6.—Knots caused by woolly apple aphids on the roots.

the species, galls are formed in which the lice multiply, safe from molestation except by parasites. When young apples are attacked, they become gnarled and knotty and remain small, hard and bitter. They usually drop from the trees, but if they do not they remain worthless, even for cider making.

MEANS OF COMBATING

Remedies for underground aphids.—Field operations directed against the ants which take such interest in the propagation of subterranean plant lice are generally more effective than those aimed at the aphids themselves. By plowing up cornfields late in the fall after the ants have become somewhat sluggish and torpid, their nests are broken up, and the aphid eggs are scattered in the earth, while the ants are too inert to rebuild their nests or to collect again the scattered eggs. Frequent plowing, disking and harrowing of infested fields in the early spring until planting time has a similar effect. These measures, together with a well-planned rotation system for the field crops, will nearly always prevent serious damage by the cornroot louse and other species of similar habits, such as the lettuce-root louse and the one that collects on the roots of asters.

In garden plots, infestation can be largely prevented by incorporating considerable tobacco dust with the soil in which the plants are to grow. When the root infestation is severe, saturate the soil around the roots with a homemade tobacco decoction or with commercial 40 percent nicotine sulphate diluted with 500 to 800 parts of water. Add 2 pounds of dissolved soap to each 50 gallons of this diluted solution. Follow the drenching with an application of tobacco dust mixed with the soil about the roots. Infested roots of trees, such as apple, pear or peach, may be given similar treatment after several inches of the top soil is removed so that the roots are exposed. These must not be left uncovered except for a brief time.

Remedies for aphids above ground.—On April 1, 1913, the European grain aphis was found to be very abundant in the Station orchard. A dozen or more young ones with their stem-mother could be found at that time on almost any swollen bud. On about the 4th or 5th of April, the trees were sprayed with a standard commercial lime-sulphur solution, diluted 1 to 8. An examination made a day or two later showed that only a few of these lice were killed or even discommoded by this spray, even when a dried film of it was coated over their bodies. Therefore, on April 9 two rows of badly infested trees were sprayed with 4 percent nicotine sulphate, 1 quart to 200 gallons of water with dissolved soap added. The rate

of dilution was 1 to 800. The spraying was done between 4 p. m. and 5 p. m. The next morning at 10.30 most of the aphids were dead, and the remainder very sick, being scarcely able to move their legs. Those on a check tree in the same row were still perfectly healthy notwithstanding the fact that they were covered with a film of dried, whitish lime-sulphur solution. On April 11 we examined 19 buds sprayed with lime-sulphur solution, 1 to 8, and found that 16 were or had been infested with lice as against 3 that were clean. On 15 of these infested buds were found 107 living lice to 4 dead ones, and these few dead ones may have been killed by causes other than the spray. Of 39 buds sprayed with the nicotine 35 were found infested and 4 clean. These examinations indicated that nearly all the buds in the orchard were badly infested. On 15 infested buds sprayed with nicotine sulphate were found 3 living lice and 115 dead ones.

On April 12 some of the trees were sprayed with a standard miscible oil diluted with 40 parts of water. On April 15, on 15 infested buds were found 56 living lice and 32 dead ones. A general inspection on this date led us to estimate that 60 percent of the lice were killed by the oil and from 98 to 99 percent by the nicotine sulphate. All the experiment stations which have conducted comparative tests are agreed that nicotine sulphate combined with soap is the best remedy for aphids. It can be combined with lime sulphate solution plus arsenate of lead or with Bordeaux mixture plus arsenate of lead. Therefore, to fit it into the established orchard schedule for spraying, it is best used in any application made just before bloom and again, when necessary, just following bloom.

If eggs are threateningly abundant on the dormant orchard wood, pruning judiciously directed will help; and also the dormant sprays for scale will prevent some of the eggs from hatching, but such a condition indicates that a very thorough spraying should be given just as the buds are opening. Soap is not needed when the nicotine is used in combination with Bordeaux or lime-sulphur mixtures.

When the leaves are so badly curled that it is impossible to hit the lice with the spray, it is often possible to dip the branch into a pail containing the spray liquid and thus insure wetting all the lice.

To spray successfully broad-leaved, running vines, such as those of cucumber and muskmelon, it is necessary to have at the end of the extension rod an angled nozzle or an "angle ell" so that the spray will be thrown upward against the undersurfaces of the leaves when the nozzle is hooked under them, and the operator is

standing upright. Aphids always collect on the undersurfaces of such leaves. It is of vital importance to keep a lookout for the first comers and to dispose of these.

Other remedies sometimes employed are fish-oil soap, 1 pound in 4 to 8 gallons of water; kerosene emulsion diluted with 12 to 15 parts of water; or Persian insect powder applied with a dust gun is quite satisfactory where only a few plants are involved. Suitable treatment for greenhouse aphids is recommended in Circular 154 of the Ohio Station.

Generally speaking, the black aphids require considerably stronger solutions to kill them than the green ones.

SPRAY FORMULAS FOR THE TOWN LOT

PAUL THAYER

There is frequent demand for spray formulas adapted to the use of the owner of a few trees or plants. Most of our formulas are based on 50 or 100 gallons of spray. Of course, anyone with a set of good scales and an aptitude for mathematics can figure out for himself one-fiftieth or one one-hundredth of a formula, but only a small number will do this to save a few gooseberry bushes, a rose bush or two, or the crop of plums on a single tree. The need for such a set of formulas, however, is not confined to town residents. Often the fruit grower has a few plants needing special attention, but the amount of spraying to be done will not warrant getting out the spray barrel or tank.

Only the principal common sprays are herein discussed, but an effort has been made to include all the sprays necessary for the control of the insects and diseases commonly attacking our fruits. This is not intended as a spray calendar but simply as supplemetary to the regular calendar. For full directions for the making and application of standard sprays see Bulletin 232 and Circular 149 of the Ohio Station. Measures are given wherever possible, because they are much easier to use than weights. These measures are based on the following table, which is the generally accepted standard:

Gallon	Quart	Pint	Level measuring cup	Level tablespoon	Level teaspoon
1	4	8	16	256	768
	1	2	4	64	192
		1	2	32	96
			1	16	48
				1	3

Attention is called to the cup mentioned above. It is the half-pint measuring cup that is coming into general use in the kitchen and is obtainable at any ten-cent store. The cup, as well as the spoons, is filled *level*, all the rest of the material being scraped off.

Copper sulphate solution.—Use a little over 2 level tablespoonfuls of copper sulphate (blue vitriol) to a gallon of water or a half-cupful to 5 gallons. The copper sulphate should be pulverized until the coarsest particles are about the size of coarse sand. Small amounts of copper sulphate may be easily pulverized by inclosing them in a cloth and pounding on a hard, smooth surface. Do not dissolve the copper sulphate in an iron or tin vessel. This is an excellent spring (dormant) spray on all plants that do not need a scale spray.

Bordeaux mixture.—Use one of the following formulas: A trifle over 2 level tablespoonfuls of copper sulphate (blue vitriol) with ½ measuring cup of hydrated lime to 1 gallon of water; or ½ measuring cup of copper sulphate with 2¼ measuring cups of hydrated lime to 5 gallons of water. Dissolve the copper sulphate and lime separately and mix; then dilute to the required amount. The making of Bordeaux mixture in such small amounts with stone lime is not practical, and hence the recommendations are for hydrated lime.

This is the standard spray for plant diseases. It is too strong for the foliage of peaches and some varieties of plums, and for them the following mixture is used (half-strength Bordeaux): 1 level tablespoonful of copper sulphate with 6 level tablespoonfuls of hydrated lime to 1 gallon of water; or, 6 level tablespoonfuls of copper sulphate with 1½ level measuring cups of hydrated lime to 5 gallons of water.

Ammoniacal copper carbonate.—The common formula for ammoniacal copper carbonate is as follows: 1 level teaspoonful of copper carbonate with 2 tablespoonfuls of ammonia to 1 gallon of water. Dissolve the copper carbonate in just sufficient ammonia to dissolve it thoroughly, and then add the water.

This spray is practically colorless when applied and is used against diseases when the fruit is so nearly ripe that Bordeaux mixture would injure its attractiveness.

Commercial liquid lime-sulphur.—The formula for the use of commercial liquid lime-sulphur in dormant strength is 1 pint of commercial lime-sulphur diluted to 1 gallon of water. This is the strength used in early spring to destroy the scale, and is most effective when used just before the buds open.

The summer strength of this spray mixture is ½ cup (scant) of commercial lime-sulphur to 1 gallon of water. This strength may be used as a summer spray in place of the standard Bordeaux mixture. The dry lime-sulphur has not yet been found successful as a summer spray.

Kerosene emulsion.—Dissolve a 1-inch cube of laundry soap in a half-pint of boiling water. Add 1 pint of kerosene and shake in a 2-quart fruit jar until thoroughly emulsified. Dilute with 15 or 20 parts of water. (This is sufficient for 3 gallons.) The stock emulsion will keep for months if stored in air-tight vessels. When carefully made and applied, this is an excellent remedy against plant lice and other sucking insects.

Tobacco solution.—The nicotine sprays on the market contain about 40 percent of nicotine. Some of the manufacturers of these sprays are putting them out in ounce vials. Their recommendations are 40 to 80 drops to a quart of water or 1 to 2 teaspoonfuls to a gallon of water. The addition of a small amount of common soap adds to the sticking property of the solution.

This spray is equally effective with kerosene emulsion against plant lice and other sucking insects. It is somewhat more expensive, but easier to prepare.

Paris green.—Paris green spray can be made in small quantities by adding 1 level teaspoonful of Paris green to 1 gallon of either water or Bordeaux mixture. It is still used as a spray against potato bugs, but for use on fruit trees it has been superseded largely by arsenate of lead.

Arsenate of lead.—Arsenate of lead spray is made by adding 1½ level tablespoonfuls of paste, or 2 level tablespoonfuls of powder, to 1 gallon of water, Bordeaux mixture or summer-strength lime-sulphur.

White hellebore and pyrethrum.—These are used when fruit is attacked by some chewing insect (like the currant worm) so near the time of ripening that it is unsafe to use arsenate of lead. The hellebore or pyrethrum is usually mixed with an equal amount of flour and dusted on the plants.

WATER-CORE OF THE KING DAVID APPLE

J. B. KEIL

Under the stimulus of considerable publicity, the King David apple has been planted by many fruit growers of Ohio. Many of these trees have come to bearing age, and reports from a few of the growers mention the tendency to water-core. The purpose of this article is to give a brief discussion of the subject, with results of cellar- and cold-storage tests at the Station.

While we are not acquainted with all the factors which bear upon the behavior of this variety in storage, the following suggestions may be offered: The immediate cause of the trouble seems to be a surcharging of the tissues surrounding the fibro-vascular bundles or core lines, which appear at regular intervals around the core of the apple, with an excess of sap. The accompanying illustration gives views of two sound apples, one slightly water-cored (Delicious), and one badly water-cored (King David).

All intermediate degrees of this trouble are found, but in some varieties tested, a large amount or sometimes all of the excess of sap is again distributed to the surrounding tissues in the ripening process. This was observed in preliminary tests of other varieties, among which Winesap, Delicious, Kinnard and Stayman Winesap, examined at the time of picking (October, 1915) were found slightly water-cored. Upon examination of similar samples stored until February 7, 1916, this condition had very largely, and in the case of Winesap entirely, disappeared. Recovery seems to be less prevalent in King David than in any other variety tested, the water-cored specimens becoming inedible and subject to early decay. This may be due to some peculiarity of texture.

The first suggestion concerning the origin of this trouble came from the introducers of King David in the caution to avoid leaving the apples on the trees too long before picking. Accordingly, it was arranged to make two pickings of the crop in the fall of 1914. The results of storage tests of two seasons are given in Table I.

TABLE I.—Results of storage tests with King David

Storage	Date stored	Date examined	Percent sound	Percent partly water-cored	Percent badly water-cored	Percent decayed
Cellar	Oct. 12, '14	Jan. 27, '15	100	..	..	..
Cellar	Oct. 23, '14	Jan. 27, '15	38	18	44	..
Cold	Oct. 12, '14	Mar. 12, '15	100	..	..	..
Cold	Oct. 23, '14	Mar. 12, '15	27	10	55	8
Cellar	Oct. 13, '15	Feb. 7, '16	100	..	..	..
Cellar	Oct. 15, '15	Feb. 7, '16	86	..	14	..
Cellar	Oct. 23, '15	Feb. 7, '16	28	..	72	..

The fact that the early-picked samples developed no water-core in storage, and came to maturity perfectly normal and sound, indicates plainly that we must be content with a moderately good coloring of King David apples, if they are to be harvested before water-core develops. Also, it appears that each grower must determine for himself the best time to pick this variety under the conditions in his orchard. For the Station this is evidently the second week in October.

Upper figure.—Variety, Delicious: left, slightly water-cored; right, sound
Lower figure.—Variety, King David: left, sound; right, water-cored

PLAN OF WORK FOR TRUMBULL COUNTY EXPERIMENT FARM

C. W. MONTGOMERY

In accordance with the requirements of Section 1177-6 of House Bill No. 163 of the Ohio laws, the following plan of work for the Trumbull County Experiment Farm was submitted by the Ohio Experiment Station to the agricultural society of that county and approved by it.

Soil fertility.—As the maintenance and increase of soil fertility will influence, to a great extent, future crop production, it is proposed to devote a considerable portion of the farm to investigations for Trumbull County requirements. These will consist of experiments to determine the effects of different kinds, quantities and combinations of fertilizers, alone and in combination with farm manure and with and without lime.

Tile drainage.—No doubt a large portion of the farm lands in Trumbull County must be tile-drained before maximum crop production can be obtained. To determine the most desirable depth and the distance apart to lay the tile and the length of time necessary for the increased crops to pay for the initial cost of draining, will be the purpose of the experiment.

Rotation systems.—It is proposed to devote several acres to various rotation systems of farm crops with a view to ascertaining which of the various systems are best adapted to local conditions.

Variety tests.—It is now an admitted fact that one of the best means of increasing crop production is to grow varieties of crops adapted to local soil and climatic conditions; therefore, a considerable part of the farm will be devoted to making variety tests of the leading crops. When the highest yielding varieties for the locality have been found, they will be multiplied and distributed among the farmers of the county.

Alfalfa experiments.—Alfalfa is now generally recognized as a plant of great value, both from the standpoint of yield and as a supplemental feed for corn. Experiments will be made to ascertain whether it can be successfully grown on Trumbull County soils.

Dates and rates of seeding.—It is proposed to make a trial of different dates and rates of seeding various farm crops.

Forage crops.—Considerable attention and space will be devoted to the economical production of maximum amounts of forage for cows from corn silage and other forage crops.

Pasture experiments.—Considerable attention will be given to increasing the productive capacity of pasture land.

Dairying and animal husbandry.—Dairying is a prominent feature of farm operations in Trumbull County. One of the vital questions in the dairy business is how to maintain a perfectly healthy herd and at the same time to have a profitable herd. For the study of these problems it is proposed to start with a small herd of cows. At a later date, should conditions warrant, some work will be carried on with hogs and poultry.

Orchard work.—It is proposed to maintain in a healthy, productive condition a small family orchard consisting of several varieties of apples, plums and cherries.

Farm management.—In cooperation with the county agricultural agent, in his other work, the farm will be devoted to discovering, developing and introducing the most practicable and profitable systems of farming for Trumbull County.

Respectfully submitted,
CHAS. E. THORNE,
Director, Ohio Agricultural Experiment Station

Approved by the Trumbull
County Agricultural Society
J. R. MUNSON, *President*
GEO. BUNTING, *Secretary*
Date Aug. 17, 1915

Because of the extent and importance of the industry in Trumbull County, nearly all the experiments have been planned with a view to solving problems of dairying. No fruit or truck experiments of a commercial nature will be undertaken, except potato growing, because the farm is not adapted to such work.

Soil fertility.—With respect to soil fertility much attention will be given to reinforcing manure with phosphorus and potassium. With applications of manure from barns with cement floors, which save all the liquids, it would seem that the organic matter of this clay soil of Trumbull County can be maintained, and that applications of potash would be unnecessary. Experiments will be made to determine these points.

If a good leguminous crop is to be obtained in this county, lime must be added in nearly all cases. Experiments will be conducted to determine the amounts required and the best form of lime to use.

Crop rotations.—Crop rotation is a world-wide agricultural principle which has been practiced in some form for hundreds of years. What crops and how often each should be grown in the rotation are matters depending upon the locality, the soil type, the size of farm and the system of farming. In this connection it is interesting to note the results of the rotation systems at the Northeastern Test Farm in Cuyahoga County, on a cold, tenacious clay soil, and at the main Station in Wayne County. The soils on both of these farms may be taken as somewhat comparable to that of the Trumbull County Farm. In these tables the selling values are figured as follows: corn, 50 cents per bushel; oats, 33⅓ cents; wheat, 90 cents; hay, $10 per ton. In feeding value 50 bushels of corn is estimated to be equivalent to 50.4 bushels of wheat or 117 bushels of oats.

TABLE I.—Results of 5-year rotations

Crop	At Strongsville*			At Wooster†		
	Average yield	Selling value	Feeding value	Average yield	Selling value	Feeding value
	Bushels	Dollars	Dollars	Bushels	Dollars	Dollars
Corn	39.99	19.99	19.99	51.81	25.90	25.90
Oats	43.14	14.38	9.25	41.72	13.90	8.91
Wheat	15.32	13.78	7.65	22.08	19.87	10.95
	Pounds			Pounds		
Clover	2,965	14.82	.....	3,837	19.18	.....
Timothy	2,913	14.56	.....	4,095	20.47	.....
Total for 5 years	.....	77.53	.....	.....	99.32	.....
Total for 15 years	.....	232.59	.....	.....	297.96	.....

*Plot 18 } 8 tons yard manure both on corn and on wheat.
†Plot 18 }

TABLE II.—Results of 3-year rotations

Crop	At Strongsville*			At Wooster†		
	Average yield	Selling value	Feeding value	Average value	Selling value	Feeding value
	Bushels	Dollars	Dollars	Bushels	Dollars	Dollars
Corn	37.02	18.51	18.51	54.15	27.07	27.07
Wheat	9.11	8.20	4.52	19.68	17.71	9.84
	Pounds			Pounds		
Clover	2,052	10.26	.....	3,523	17.61	.....
Total for 5 years	.....	36.97	.....	.....	62.39	.....
Total for 15 years	.....	184.85	.....	.....	311.95	.....

*Plot 26 } 8 tons yard manure on corn.
†Plot 15 }

It will be noted from these tables that the selling value in 15 years of the crops in the two systems of rotation at Wooster are not far different, but at Strongsville the gross receipts are much in favor of the 5-year rotation. In this connection it should be explained that the 3-year rotation at Strongsville did not extend over so long a period as the 5-year rotation, and that the land for the former rotation was not tiled until the fall of 1914, while the land for the latter rotation had been tiled for a number of years. It should also be noted that at Strongsville the 3-year rotation includes wheat, which for that section is a crop of lower value than oats. For this reason wheat was not planted in the fall of 1914, but oats were substituted the following spring; and now the rotation is corn, oats, clover.

It is interesting to note that the grain in the 3-year rotation, both at Strongsville and at Wooster, in 15 years, surpasses that in the 5-year rotation in feeding value. However, the cost of growing the crops and the distribution of labor are factors which enter largely into the question as to what crops shall be grown.

It is barely possible that, if the feeding value of corn was measured in terms of silage rather than in terms of grain, the showing of corn might be much better than is given in this table. It is generally recognized that in feeding value clover hay is far superior to timothy for dairy cows. The question then arises, why should wheat and timothy, especially wheat, be grown in Trumbull County when their selling and feeding values are so low to the acre? It is said that better stands of clover are sometimes secured with wheat than with oats. This may have been true when it was customary

to plow for oats; but, since tests at the main Station have demonstrated that better crops of oats are grown by disking corn stubble than by plowing, it is possible that fully as good stands of clover would result from seeding with oats as with wheat if this practice were followed in Trumbull County.

A number of rotations have been planned with a view to solving the problem of producing the greatest amount of cow feed to the acre, and at the same time to maintain the fertility of the land. As these rotations are continued in comparison with the old 4-year and 5-year rotations, some definite conclusions may be expected. These rotations are as follows:

Rotations for Trumbull County Experiment Farm

Two-year rotations:
- A—Corn, soybeans
- B—Corn, clover
- C—Corn, peas and oats, soybeans, rye (catch crop)

Three-year rotations:
- D—Corn, oats, clover
- E—Corn, rye, clover
- F—Potatoes, oats, clover

Four-year rotations:
- G—Corn, oats, wheat, clover
- H—Corn, potatoes, oats, clover
- I—Corn, soybeans, wheat, clover
- K—Corn, oats and peas, soybeans, rye, clover

Five-year rotation:
- L—Corn, oats, wheat, clover, timothy

In Rotation A rye and vetch will be sown in the corn at the last cultivation, to be plowed down the next year for the soybeans. The soybeans will be cut for hay, and rye sown to be plowed under the next year for corn.

In Rotation B clover will be sown in the corn at the least cultivation. Should the clover fail to make a good stand, some substitute crop like soybeans will be put in the next year.

In Rotation C an attempt will be made to grow two hay crops the year following corn; that is, oats and peas will be cut early and the land then sown to soybeans as the second hay crop.

It is contemplated that in these 2-year rotations all the crops will be fed to dairy cows. The manure will be reinforced with acid phosphate and returned to the land. It will be noted that these rotations do not provide bedding; hence, it is thought best to supplement them with a rotation of grain crops which, besides furnishing straw, would provide concentrates to be fed with the silage.

Since it is not presumed that every farmer of Trumbull County would care to feed all his crops to dairy cattle, some rotations were planned in which all or a part of the crops are sold.

THE MINERAL NUTRIENTS IN PRACTICAL HUMAN DIETETICS

E. B. FORBES

In the consideration of the mineral nutrients of the human diet we are impressed especially with the incompleteness of the scientific evidence on the question, and the difficulty of making really practical applications of this evidence. Only in the case of infants, invalids, lunatics and convicts does it seem practicable to regulate the human diet with the same particularity with which the successful livestock farmer feeds his animals. In spite of the difficulties of the task, however, and the indifference of most of us to the economic and rational aspects of our own eating, there are those dependent upon us who should have the benefit of our wisest counsel, even though we put ourselves in the position of saying, "You are to do not as I do, but as I say."

Importance of a study of mineral nutrients.—Regarding the functions performed by the minerals, suffice it to say, for present purposes, that they are so deeply involved in every vital process that life could not endure if its complex mineral requirements were not automatically and constantly maintained in almost perfect adjustment. What then are the facts which warrant the practical consideration of this subject? They are that in pathological states these functions are somewhat deranged, and that life as we live it is in many respects highly abnormal, in the sense of differing from that to which human metabolism is attuned; and with our ever-increasing social differentiation life puts increasing stress upon the integrity of the body and its normal processes. In relation to food materials there are also important facts bearing on this matter of the mineral nutrients; for, while highly developed processes of food manufacture and efficient world-wide transportation give us the greatest opportunity for correct dietetics that there has ever been, these same agencies open the way to greater unwisdom and abuse in dietetics than were possible in our more primitive days. The net result is an obligation on our part to prepare a defense of knowledge against the misfortunes of prosperity.

Control of human mineral metabolism impossible.—It is my belief that anything like exact quantitative control of human mineral metabolism, as a practical measure, is as impossible as it is unnecessary; impossible first, because any kind of control of human dietetics is very difficult; second, because our knowledge of the

optimum mineral requirements of human beings is especially slight and fragmentary; third, because the interactions of the mineral elements among themselves affect mineral metabolism in such prominent ways that fixed and definite statements of mineral requirements are quite apt to be misleading. And exact control in these matters is unnecessary because of the existence of safety provisions, for bridging over temporary deficiencies, of a perfection in harmony with the surpassing importance of mineral metabolism.

It is my belief, therefore, that in our present state of knowledge practical advice regarding the mineral metabolism of healthy human beings may most properly be general in character, and in the nature of recommendations of *types* of food products which should predominate in the diet under the various conditions of life, growth and activity.

MINERAL ELEMENTS IN FOODS

Common salt.—The one mineral salt which we use as such—sodium chloride—occupies a unique position among the mineral nutrients. Within wide limits it seems to make little difference how much sodium chloride we consume, and the kidneys excrete that salt without marked energy expenditure. Under certain conditions excessive intake causes slight increase in nitrogenous outgo, but such abnormal consumption would result in indigestion before the increased destruction of protein would become important in extent.

Our habitual consumption of salt in amounts much in excess of actual requirements, and certain facts regarding the excretion of salt are probably due to the marine origin of all vertebrate animals, and to their early adaptation to life in a solution of this salt.

Other important elements.—Calcium, phosphorus and iron are more likely than other mineral nutrients to be lacking in human dietaries. On this account especial interest attaches to their occurrence in food. Calcium is especially abundant in milk, and is also contained in considerable quantities in eggs, vegetables and fruits. Phosphorus is abundant in milk, eggs, nuts, peas, beans and such cereal products as contain the outer seed coats. Iron is found in largest quantities in beef, eggs, beans, peas, green vegetables (especially spinach) and the outer seed coats of the cereals. The foods which are the poorest in minerals are polished rice, pearl hominy, white flour, bolted cornmeal and other cereal foods which lack the outer seed coats. These foods, because of their highly digestible character and lack of salts, are apt to be constipating. Magnesium is abundant in the cereals and is not apt to be deficient

in normal rations. The magnesium salts of the outer seed coats of cereals contribute a laxative character to foods containing them. Enough sulphur is contained in the protein of any ration which supplies the nitrogen requirement. Potassium is found in considerable quantities in most normal foods and is also present in sufficient amount in almost all diets. Manganese, boron, silicon and iodine are among the less abundant minerals in the body, the presence of which in the necessary quantities in the diet we take for granted. Further study may show some of these assumptions to be unwarranted.

In considering the mineral requirements of human beings we may bear in mind the fact that more than three-fourths of the ash of the body is in the skeleton, which includes about 88 percent of the phosphorus and more than 99 percent of the calcium of the entire body. Thus, in discussing mineral requirements of the organism as a whole, we have to do very largely indeed with the skeleton, but we must not overemphasize these facts, for the quantities involved are no gauge of functional importance, as is illustrated by the fact that iodine, which is found in the body in infinitesimal amounts, is just as essential as the pounds of calcium.

MINERAL REQUIREMENTS OF THE BODY

During the several stages of life there is, from birth to maturity, in general a decreasing requirement in the proportion of minerals to other necessary nutrients, but with periods of increased demand due to unusual functional activity, especially during puberty, pregnancy and milk secretion. The usual mineral requirements of mature human beings are comparatively slight, and are probably satisfied by all normal diets (provided we specify with some particularity as to what constitutes a normal diet). It is, therefore, during rapid growth and during the reproductive life of women that the mineral nutrients are especially in demand, and it is at these times that lack of mineral nutriment and irrational hygiene cause or aggravate a number of well-known pathological conditions which are characteristic of these states of being. We shall mention in detail the mineral requirements at some of these times of greater need.

Requirements of infants.—The normal food of the human infant naturally furnishes its full mineral requirement. This subject becomes of interest in this connection, therefore, in cases of artificial feeding and in certain metabolic derangements. For an artificial food we naturally turn to cow's milk, which because of

high fat and casein contents must be liberally diluted. If water is used, the necessary dilution reduces the minerals, the albumin, the lecithin and the so-called accessory nutrients to an undesirable extent. The best diluent is whey, which anyone can prepare with the aid of a thermometer and a commercial rennet preparation in a few minutes. (The whey must be heated to 68° C. or 154° F. to kill the enzyme, before it is mixed with milk.) With combinations of whey, skimmilk, cream and milk sugar the intelligent parent can rear an infant which can live at all. The especial usefulness of whey is due to its abundant mineral content in natural physiologic solution. It serves as a stabilizer—a corrective. The use of whey powder (evaporated whey) results in a saving of much labor in the preparation of the infant's food.

The infant is born with a store of iron within its body. During the nursing period this store is gradually depleted, since the milk contains little iron. At weaning time the infant stands in need of iron. This is usually supplied in egg yolk, beef press juice, scraped beef, prunes, whole wheat foods and oatmeal, and some physicians of unquestioned standing recommend spinach. Egg yolk is of especial value as a source of iron, calcium, phosphorus and lecithin, but it is an exceedingly rich food. It must be fed with great care on two accounts: first, to avoid making the baby sick, because while it is usually well taken it acts like poison to some infants; and, second, because the value of egg is so great that it is especially unfortunate if you upset the infant by an overallowance, since it may be a long time before it will regain its tolerance for this food.

Infant diseases due to mineral supply.—The commonest metabolic disturbance in infants is gastrointestinal indigestion. Its most frequent cause is a weak digestive apparatus and too much fat in the food. Alkali soaps, formed in the intestine, instead of being digested and absorbed are passed off in the feces. Alkalis are lost from the body; mineral acids are left to predominate; infantile acidosis ensues. What shall we do? Reduce the fat in the food and add sodium citrate to furnish an oxidizable alkali salt.

Because of its low oxidative capacity the infant is especially subject to acid intoxication from relatively slight causes, the acid excess being due to the normal acid products of metabolism and to imperfectly oxidized organic compounds, especially betaoxybutyric acid. We have mentioned the weak digestive apparatus and deficient capacity to handle fat. Undernourishment also causes acidosis in infants. Fever is a very common cause. In all these cases whey is especially valuable. Many a child has been taken through long

sieges of fever on whey. Children do not lose weight rapidly on whey alone. Egg white and fruit juice, especially that of the orange, may be used with whey to advantage; they furnish some nutriment and appreciable amounts of alkali.

In connection with the mineral metabolism of infants mention must also be made of rachitis. The cause of this disease is unknown. It is not due *primarily* to lack of minerals in the diet and does not respond readily to simple increase of minerals in the food, though calcium salts administered with phosphorized cod-liver oil are usually beneficial.

The existence in infants and older children of simple malnutrition of the bones, a common malady in young farm animals, is not well established; and the prevalent imperfections of children's teeth are not certainly related to deficiencies in the diet, but seem rather to be caused by lack of exercise (due to the fine milling of our cereals and the chewing of our meat with a sausage mill), the increasing use of sugar (a readily fermentable, acid-producing food) and increasing use of fruits, the organic acids of which soften the tooth enamel.

Requirements for growth.—Beyond the period of infancy the mineral nutrient which is most commonly lacking in the diet is calcium, though phosphorus also may be deficient; and the iron content of the diet is sometimes inadequate, as evidenced by the existence of anemia in children.

For purposes of growth our best single sources of mineral nutriment are milk and eggs. Of these, milk lacks only iron, and eggs only calcium. The incubating bird supplements the moderate calcium content of the egg by absorbing an appreciable amount of lime from the shell.

Requirements of reproductive life of women.—During the reproductive life of women liberal use should be made of the iron-containing foods, such as beef, eggs, fruits and green vegetables, especially spinach, green beans and cabbage. Lactation makes a heavier demand upon the mother for mineral nutriment than any other incident in her life, and the most efficient method of providing the mineral requirement is, naturally, through the use of milk, or foods made from milk.

Loss of minerals in old age.—In old age there seems to be an absorption and loss from the body of much bone substance coincident with the general wasting away of the tissues. This is most apparent in the receding of the processes of the jaw bones and the absorption of the spongy structure of the interior of the long bones.

This appears to be a physiologic process, and we have no evidence that it is affected one way or the other by the minerals of the diet, though it is conceivable that there might be some such influence.

General requirements.—A high ash content of the food is desirable, since the organism is much more able to handle an excess of ash constituents than to meet a deficiency. It is good practice, therefore, to utilize the water in which foods are cooked, in so far as this can be done without detracting from the acceptability of the food, since the cooking-water dissolves out much mineral matter. An abundance of mineral salts in the diet is also desirable, aside from nutritive considerations, because they contribute a laxative character to the food. Foods which are deficient in minerals are apt to be constipating.

A general character of the mineral nutrients of foods is the predominance of acid or basic elements. If the nutrients are present in the proportions in which they are needed, the bases will predominate; and it is probably best that the bases should exceed the acid elements in the diet. It is true, however, that the body has the capacity to neutralize a considerable excess of acids. Meats, eggs and cereals have acid ash; vegetables, milk and most fruits have alkaline ash. The latter group should be liberally represented in the diet.

The diets which are most likely to supply sufficient of each of the minerals are those characterized by liberality and diversity. Extreme simplicity of diet is not advantageous. The usual diets of prosperous Americans do not lack mineral nutrients. But we are not all prosperous, and some of us choose unusual dietetic combinations. The central features of improperly chosen diets are usually an undue dependence upon meats and foods made from finely milled cereals or other cereal foods lacking the outer seed coats, and too little use of milk and vegetables.

NOTICE

CHANGE IN FORM OF PUBLICATION

In order to carry the results of the work of the Ohio Experiment Station more promptly and in more practical form to the farmers of the State, and to place the scientific phases of this work in a form more useful to teachers and scientific investigators, it has been decided to issue the publications of the Station in two series; namely:

1. A series of "Technical Bulletins," which will be a continuation of the regular series heretofore issued, but which will hereafter be limited in scope to a technical record of the Station's investigations and will be distributed only to libraries and to such persons as may especially request them. This series will also serve the purpose of the former "Technical Series," of which eight numbers have been published, and which will now be discontinued.

2. A "Monthly Bulletin," which will be published as a monthly journal, each number containing several brief, non-technical and timely reports of progress on different phases of the Station's work, written for the purpose of illustrating the practical application of this work to the agricultural conditions of Ohio. This Monthly Bulletin, in respect to distribution, will take the place of the Bulletins, Circulars and Press Bulletins heretofore issued. It will be sent free to the Station's present mailing list without further request, and to any others who may ask for it, but the "Technical Bulletins" will be sent only on special request. These bulletins will be advertised, when issued, in the Monthly Bulletin.

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